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Brush sealing ring

The invention relates to a brush sealing ring for use as a sealing element between two components which can move relative to one another, as claimed in the preamble of Patent Claim 1.

Brush sealing rings of this type can be provided with bristles which protrude radially outwards, radially inwards or in an axially lateral direction. An installed brush sealing ring forms the actual brush seal by interacting with a smooth, wear-resistant component corresponding surface with a preferably circular cylindrical or planar geometry. In order to keep the bristles free of centrifugal forces, the brush sealing rings are generally installed fixed to the stator. In addition to rotating components, such as shafts, oscillating or quasi-static components which do not move very much can also be sealed with brushes, such a seal being non-hermetic, i.e. operating with a certain degree of leakage. The media which are to be sealed are preferably gaseous.

DE 3429 708 C1 protects a brush seal whose bristles are embodied as a composite of materials. Here, the core of the bristles is to be spring-elastic, i.e. deformable in a reversibly elastic fashion, and the coating of the bristle is to be a good thermal conductor and to reduce friction and wear. A multiplicity of materials or combinations of materials which may be suitable in this sense are mentioned. Inter alia, reference is made to plastic as a core material or sheath material, and the table at the end of the description specifies Kevlar, i.e. aramid fibres, as a brush core material which can be metallically coated. The overall context, specifically

the figures, indicate that here bristles are meant in the sense of straight, separate sections of material which have defined cross sections and which can be handled satisfactorily, for example grasped, bundled, clamped, soldered, adhered, sintered etc.

Anyone familiar with the term "angel hair-like" structure of aramid fibre strands or threads etc. is aware of the fact that it is not possible to fashion them into bristles or brushes according to the abovementioned patent, or it is possible to do so only with an uneconomically high level of expenditure.

EP 0 211 275 B1 relates to a method including a device for manufacturing a brush seal using winding technology. Here, bristle material in thread form or wire form is wound over two parallel spikes, held with clamping bars and cut between the spikes. The resulting, initially straight brushes are bent to form rings and joined so that continuous brush sealing rings with bristles protruding on one side are obtained. The ends of the bristles can then be machined more precisely to a finished dimension by shortening. The patent is aimed mainly at metal and ceramics as bristle material, i.e. at "wire-like" hard material with a defined cross section. The silicon carbide fibre (SiC fibre) which is of particular interest in this context - in addition to metal - presents problems in that they can no longer be wound around narrow radii in the thickness which is preferred for brushes so that a core (spike) which is greater in cross section and a clamping section which is correspondingly greater in diameter is required. The method protected by the EP Patent has to date been essentially used only for metal brushes.

DE 197 20 649 A1 deals with a brush seal having a special

housing geometry which improves the support of the bristles during operation, i.e. when there is a pressure difference, and as a result reduces the leakage. The loop-like bristle arrangement around a wire core with securing by means of a clamping element is familiar. Such a brush sealing ring can advantageously be fabricated using the method according to EP 0 211 275 B1. DE 197 20 649 A1 does not contain anything specific relating to the bristle material.

In view of the above, the object of the invention is to configure a brush sealing ring with aramid fibre-based bristles, which is distinguished by favourable manufacture, a definite and reproducible brush structure and a satisfactory and predictable sealing behaviour.

This object is achieved by means of the combination of features characterized in Claim 1, in conjunction with the genus-forming features in its preamble.

Surprisingly, it has been found that the fine "angel hair-like" strands or threads of aramid fibres can reliably be secured and oriented by clamping, i.e. frictional locking. The loop-shaped arrangement around a core gives rise to a particularly low-stress, reliable securing means by virtue of a large "clamping length" per bristle/section in contact with a clamping section which engages around it. An important aspect in terms of fabrication technology is that the bristles are sections of strands or threads which are present in a wound arrangement, because the aramid fibre material to be used can only be handled effectively using winding technology. It is to be noted that a brush of this kind does not have any clearly distinguishable, stiff bristles with defined cross sections but rather resembles a fine hair paintbrush with hair geometries which vary within limits.

Preferred embodiments of the brush sealing ring according to the main claim are characterized in the subclaims.

The invention will be explained in more detail below with reference to the drawing. The figure shows, in a view which is not to scale, a cross section, i.e. an axially radial section, through a brush sealing ring.

The brush sealing ring 1 has an annular, at least essentially rotationally symmetrical housing 2 as a supporting, protective and also sealing element. For reasons of fabrication, the latter is composed of two parts, a cover plate 3 and a supporting plate 4, which overlap here axially in the upper region and are connected in a positively locking fashion, preferably by means of beading. The longitudinal centre axis X of the brush sealing ring 1 is located here on the side of the housing 2 on which the bristles protrude from said housing 2. The bristles thus protrude regionally inwards towards the centre from the contour of the housing in order to interact with the central, round corresponding component, in particular a rotating shaft, in which case the axis of the corresponding component (not shown here) should be identical to the longitudinal centre axis X. The brush sealing ring could also be structured in such a way that the bristles protrude radially over its outer circumference in order, for example, to interact with a hollow shaft as a corresponding component. Taking the present view as a point of departure, the longitudinal centre axis would then have to lie above the sectioned housing.

A further embodiment of the brush sealing ring could also be such that the bristles protrude axially out of the housing in a lateral direction and interact with a corresponding component which is planar in the sealing

region. Taking the present view as a point of departure, the longitudinal centre axis would then run vertically and lie laterally to the right or left of the housing section.

All these modifications do not have any influence on the essence of the invention.

The actual invention consists here in a structural design of the brush which is as appropriate as possible for the materials. The starting material for the bristles fibres made of aromatic polyamides, i.e. aramid fibres, which tend to be known under the designation "Kevlar" or "Kevlar fibres". The fibres are combined to form strands or threads which are available in a wound form. Sections which form the bristles of the brush are made of the strands or threads. Whether one considers such a section, or only a plurality of sections, as being a "bristle" is optional and ultimately insignificant.

In the case of aramid fibre brushes which exhibit a fine, soft structure, it would perhaps be better to speak of "brush hairs".

For the sake of clarification, only two sections 5, 6, i.e. "Bristles" are shown in the figure, the thickness of said bristles being an order of magnitude too large in the illustration and in reality tending to be in the region between a few thousandths and a few hundredths of millimetres. The sections 5, 6 are wrapped in the manner of a loop around a round core 11 and extend away from it on both sides without crossing over in such a way that in each case both end faces 7,9 and 8, 10 of each section 5 and 6 form tangents with the same - imaginary - face F which is at least approximately conformal with the surface of the corresponding component, i.e. corresponds here to a - spacial - circular cylindrical face with the

longitudinal centre axis X. The slightly bent arrangement of the sections 5, 6 with lateral abutment against the supporting plate 4 reflects the operating conditions with excess pressure on the side of the cover plate 3, i.e. on the left-hand side. The sections 5, 6 are secured to the core 11 in a frictionally locking fashion by means of a C-shaped clamping section 12 which is prestressed by means of elastic cross-sectional widening and which can be formed from a slotted tube. Outside the clamping region, i.e. from the face F to the part 12, the sections 5, 6 run - in the unloaded state - in an essentially radial direction or in a radial direction and circumferential direction, i.e. with a defined attitude angle (up to approximately 45°) in the circumferential direction. Obliquely positioned "bristles" are more pliant in the radial direction, i.e. they compensate better for deviations in position in the corresponding component. However, a rotation of the shaft is permitted only in the oblique direction of the "bristles". A person skilled in the art is familiar with this and there is therefore no need for it to be presented in more detail. The "bristles" are, according to the invention, sections 5, 6 of strands or threads made of aramid fibres which are present in a wound arrangement. According to a method cited at the beginning which is protected by a patent, the strands/threads are wound around two straight cores which are spaced apart in a parallel arrangement and are secured thereto by means of clamping sections. The windings are then displaced axially with respect to one another in order to generate an attitude angle. The windings are then cut centrally between the cores so that two identical, straight brushes, each with a core and clamping section, are produced. These are bent in an annular shape and joined at a joint by welding, soldering, adhering or the like, during which process care has to be taken to ensure that the plastic fibres

are not damaged or destroyed thermally. Inter alia, a strut joint with solder points would be conceivable, in which case heat can be conducted away via the solder contacts. Each annular, coherent brush is integrated into a two-part - or multi-part - housing so that the desired brush sealing ring is obtained. The free, protruding bristle ends can then be machined more precisely to their dimensions (face F).

The tough, tear-resistant aramid fibres are relatively difficult to cut so that special cutting methods may be necessary. Apart from mechanical cutting, punching, edge-trimming etc., in particular laser beam cutting without and with cooling or water beam cutting without and with abrasive additives are conceivable here.